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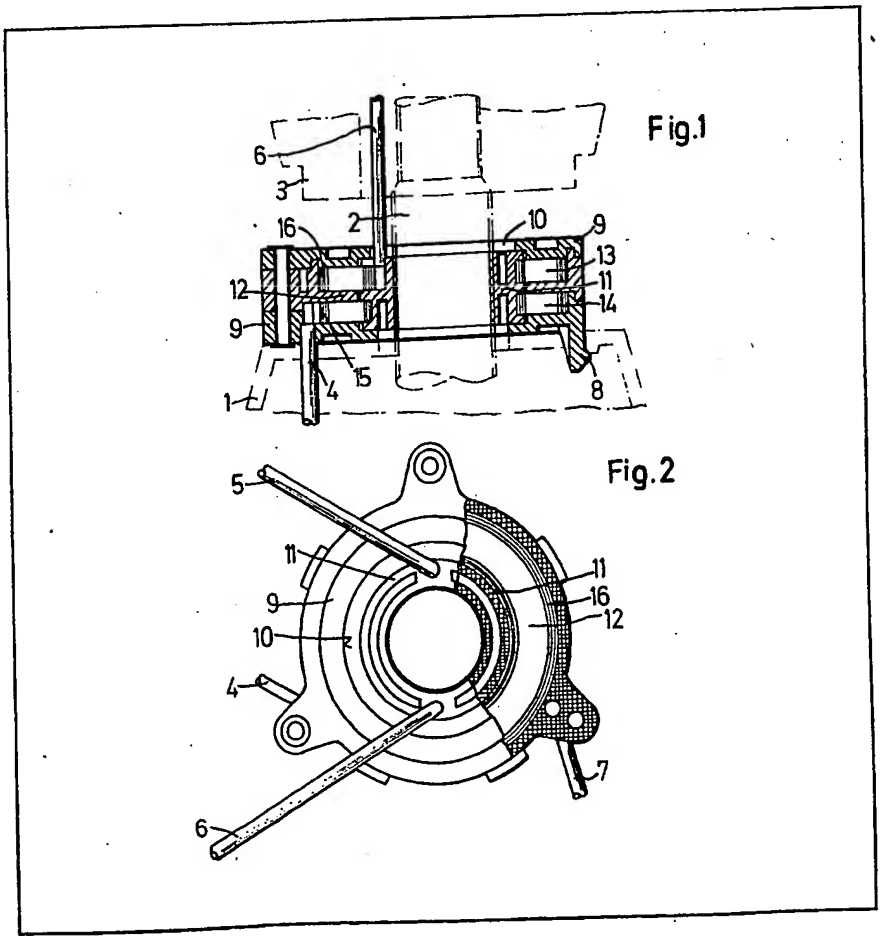
(54) **Electrical connector**

(57) An electrical connector for maintaining a circuit between two components (1,2) when relative rotational movement between the components takes place, the connection being effected by one or more coil or loop springs (15,16), the or each spring surrounding a core member (11) which moves with a rotatable member (2). In the described embodiment coil spring (15) connects terminal (4) to terminal (5) and coil spring (16), which may have its convolutions extending in the opposite direction to those of coil spring (15) to provide tension compensation, connects terminal (7) to terminal (6). In the embodiment of Figure 3 (not shown), separate rings (17,18) take the place of core 11, facilitating the adjustment of the coil springs into a central position from which rotation of the steering spindle (2) in both directions is possible before assembly of the connector. The two rings (17,18) are subsequently locked together with a locking pin.



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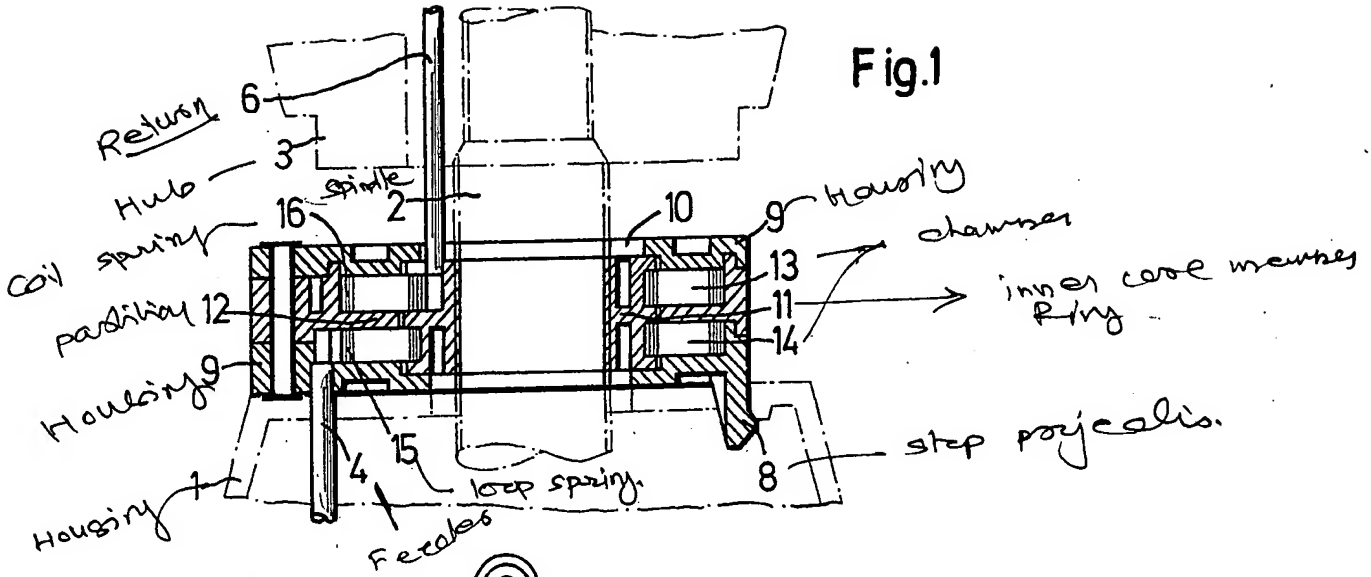

Fig.1

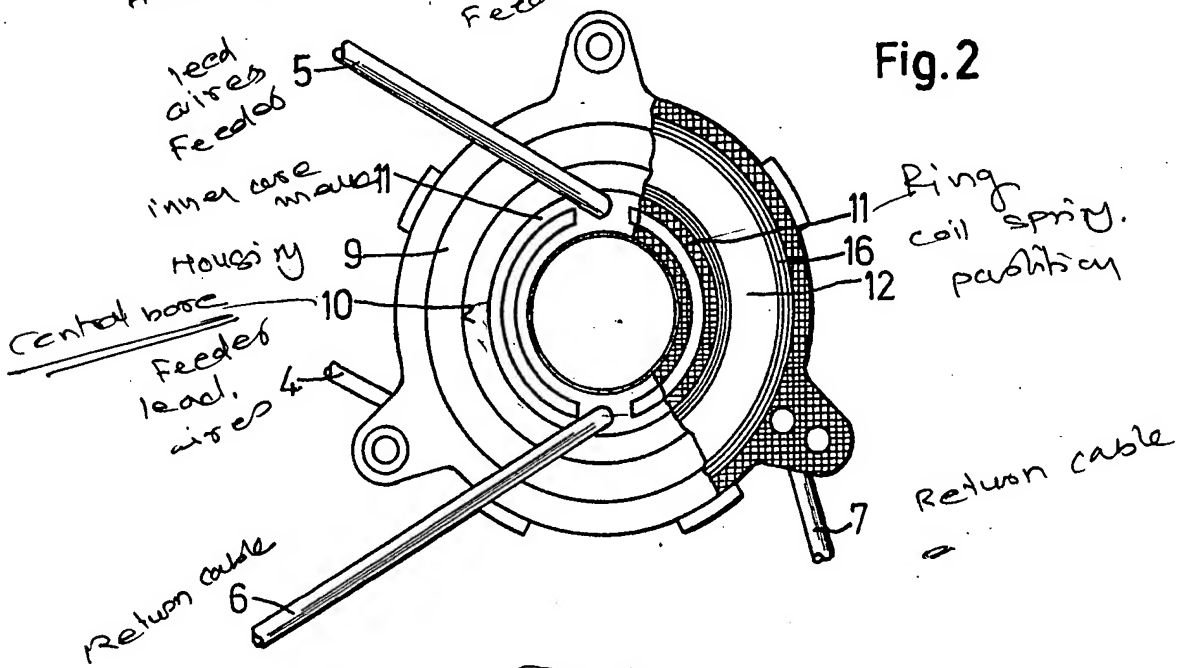

Fig.2

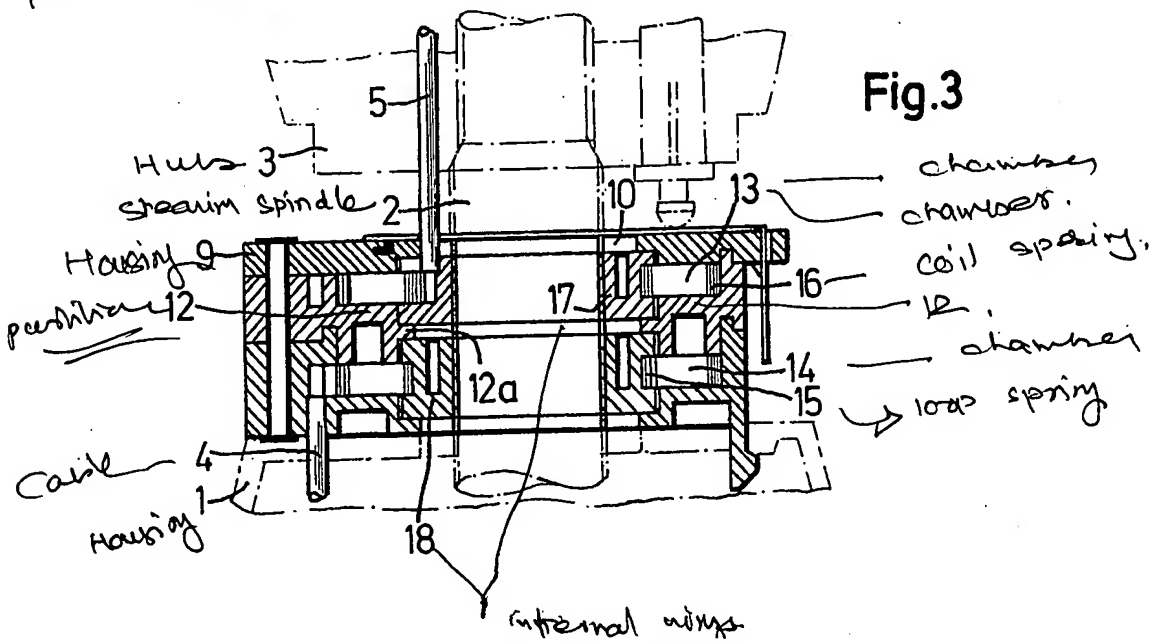

Fig.3

SPECIFICATION

Electrical connector

The present invention relates to an electrical cable connector for maintaining an electrical circuit between two components when relative rotation between the components takes place.

The maintenance of an electrical circuit between two components when relative rotation between the components takes place has hitherto been effected by means of collector contact members. Inter alia, such collector ring contact members are used in the car construction industry to bridge an interruption in the actuating circuit of gas bag protection devices. This interruption occurs between a fixed housing for the steering spindle and the steering spindle or steering wheel boss or hub which is rotatable in the housing from a central position by up to four revolutions in each direction of rotation.

It has been found, however, that many of the known failures in otherwise satisfactory gas bag protection devices can be attributed to a break in the actuating circuit in the region of the collector ring contact members. On examination, this has been found to be due to the fact that, under the effect of the considerable inertia forces occurring during an accident, the contact pin has lifted off the collector ring at least for a few vital fractions of a second. The contact-breaking thus caused leads directly to the failure of the actuating circuit and hence of the protective device itself. It has also been found that, the circuit can be broken due to the formation of layers of ice on the contact surface and that it is difficult to ensure, with suficient reliability, that this does not occur.

The present invention seeks to provide a cable connector which substantially obviates the need for a collector ring arrangement but which ensures an electrical connection between the components between which the relative rotation takes place. In so doing, the invention seeks to provide a connector which does not interfere with the rotatability of the rotatable component or components.

According to the present invention, there is provided an electrical connector for maintaining an electrical connection between two components between which relative rotational movement can take place comprising a rotatable core member located in a central bore formed in an annular housing, the core member being connectable to the rotatable component and at least one coil or loop spring member made of an electrically conductive material concentrically surrrounding the core member, the spring member at least partially filling the annular space of the housing, one end of the or each spring being connected to a current feeder terminal and the other end thereof being connected to a current tapping terminal, one of said terminals being located in the wall of the housing and the other terminal being located in the rotatable core member.

Such a cable connector permits current transmission, without the use of contacts, especially of the collector ring type from a fixed member to a member electrical connection does not obstruct the freedom of rotation of the rotatable member. It is thus particularly suitable for use as the connector between the steering spindle housing and the steering spindle of an automotive vehicle in the actuating circuit of a gas-bag safety device.

The freedom of rotation, that is to say, the number of revolutions which the rotatable member can make is variable within wide limits and is determined by the number of convolutions of the springs. Each convolution corrresponds to a freedom of rotation of one revolution of the spindle, whilst the width of the chamber in which the spring is located slightly exceeds the thickness of the spring assembly. The two end positions of the springs correspond to the end positions of the steering spindle. In one end position, all of the convolutions of the spring are compressed against the outer wall of the housing and in the other end position, all of the convolutions of the spring are compressed against the core member.

In direct current circuits in which the electrical component which is served by the circuit is directly earthed, a single core member surrounded by a single loop spring may be provided. Preferably, however, the interior of the housing is partitioned into two axially juxtaposed chambers, a loop or coil spring being located in each chamber, each spring being separately connected to one feeder and one tapping terminal. This makes it possible to provide a single core for both of the coil or loop springs. It is also expedient, in examples of use such as the steering assembly of an automotive vehicle in which rotation from a central position in two directions of rotation is necessary, if the coils of the springs are wound in opposite directions. By so doing, there is an automatic balancing of forces when the rotatable member, such as the steering spindle, is in its central position. This considerably facilitates the mounting of the connector. In such a case, however, it is necessary to provide separate cores in the housing for each of the two springs, which cores are rotatable independently of one another.

The invention will be further described, by way of example, with reference to the accompanying drawings, in which :-

Figure 1 is a section through a cable connector in accordance with the invention installed in the steering system of an automotive vehicle,

Figure 2 is a plan view of the cable connector shown in Figure 1, the housing therefor being partly broken away to show interior detail, and

Figure 3 is a view, similar to Figure 1, of an alternative embodiment of a cable connector in accordance with the present invention.

In Figures 1 and 3, there are shown, in phantom lines, various components of the steering system of an automotive vehicle. These are a fixed spindle housing 1, a steering spindle 2 which is rotatable in the spindle housing 1 and the boss or hub 3 of the steering wheel. An electrical circuit, such as the ignition circuit comprises a feeder cable or lead 4, 5 and a return cable or lead 6, 7. The cable portions 4 and 7 are located in the spindle housing 1 and the

rotatable steering wheel boss or hub 3. A housing 9 for the cables is mounted on the spindle housing 1 by means of stop projections 8. The housing 9 is thus also fixedly mounted. The housing 9 has a central bore 10 formed therein in which an inner core member 11 is rotatably mounted. If necessary or desired, the core member 11 may be in the form of a ring which surrounds the spindle 2 but is non-rotatable relative thereto.

In the embodiment shown in Figure 1, a partition 12 is provided in the interior of the housing 9, which partition 12 divides the interior of the housing into two axially super-posed chambers 13 and 14. The radially inner surfaces of the chambers 13 and 14 are formed by the ring 11. In each of the two chambers 13 and 14, a loop or coil spring is provided, a large number of convolutions of which concentrically surround the ring 11. The ends of each spring are connected to a feeder cable terminal or to current tapping terminals, one of these terminals being formed in the housing 9 and the other being formed in the ring 11 rotatably mounted in the housing. In Figure 1, it can be seen that the loop or coil spring 15 in the lower chamber is connected to the fixed feeder cable 4. On the other hand, the return cable 6, which is mounted in the boss or hub 3 and rotates therewith, projects through the bore 10 formed in the upper wall of the housing 9 into the ring 11 where it is connected to the radially inner end of the loop or coil spring 16 provided in the upper chamber 13. Similarly, as can be seen in Figure 2, the outer end of the loop or coil spring 16 is connected to the fixed cable or lead 7 and the inner end of the loop spring 15 is connected to the lead or cable 5 which extends into the core or ring 11 and therefore rotates with the boss or hub 3. By assembling the two coil or loop springs 15 and 26 so that their convolutions extend in opposite directions to one another provides a tension compensation device within the connector in the sense that no rotary forces or torques act on the steering spindle 2.

In the embodiment shown in Figure 3, in which identical parts to those shown in Figures 1 and 2 are denoted by the same reference numerals, the partition 12 has an inwardly projecting annular lip 12*a* which separates the two chambers 13 and 14 and which also acts as a mounting for two separate internal rings 17 and 18 which take the place of the core or ring 11. In this manner, the adjustment of the two loop or coil springs into a central position from which rotation of the steering spindle in both directions is possible before assembly of the connector, is facilitated. It is thus subsequently necessary only for the two cores to be mutually interconnected and locked together by means of a locking pin.

CLAIMS

1. An electrical connector for maintaining an electrical connection between two components between which relative rotational movement can take place comprising a rotatable core member located in a central bore formed in an annular housing, the core member being connectable to the rotatable component and at least one coil or loop spring member made of an electrically conductive material concentrically surrounding the core member, the spring member at least partially filling the annular space of the housing, one end of the or each spring being connected to a current feeder terminal and the other end thereof being connected to a current tapping terminal, one of said terminals being located in the wall of the housing and the other terminal being located in the rotatable core member.

2. A connector as claimed in claim 1, wherein the interior of the housing is partitioned into two axially juxtaposed chambers, a loop or coil spring being located in each chamber, each spring being separately connected to one feeder and one tapping terminal.

3. A connector as claimed in claim 2, wherein the two coil or loop springs are electrically insulated from one another and are each connected to a terminal in a common core member.

4. A connector as claimed in claim 2 or 3, wherein the coil or loop springs are coiled in opposite directions to one another.

5. A connector as claimed in any one of claims 1 to 4, wherein the core member is in the form of a ring.

6. A connector as claimed in any one of claims 1, 2, 4 or 5, wherein a separate core member is provided for each coil or loop spring, said cores being interconnected and locked against mutual rotation.

7. An electrical connector constructed and arranged to operate substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 or Figure 3 of the accompanying drawings.

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